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CCI+ PHASE 1 – NEW ECVS

PERMAFROST

CCN 3

ROCK GLACIER KINEMATICS IN THE CARPATHIANS (CCN1 BUDGET EXTENSION)

Climate Research Data Package (CRDP)

VERSION 1.0

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PREPARED BY

b·geos

GAMMA REMOTE SENSING

West University of Timisoara

TERRASIGNA

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Author team

Flavius Sirbu and A. Onaca, WUT

V. Poncos, TERRASIGNA

Tazio Strozzi, GAMMA

Annett Bartsch, B.GEOS

ESA Technical Officer:

Frank Martin Seifert

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1 INTRODUCTION

1.1 Purpose of the document

The Climate Research Data Package (CRDP) describes the products generated within the CCN1 budget extension for "Rock glacier kinematics in the Carpathians (Romania)" performed within CCN3 of the Permafrost_CCI project. The two outputs are the rock glacier velocity (RGV) in the Retezat Mountains, Romania, and the updated version of the rock glacier inventory for the Southern Carpathians that includes the kinematic information.

1.2 Status of the document

This is the only issue of the CRDP for the CCN1 budget extension CCN1 "Rock glacier kinematics in the Carpathians (Romania)" performed within CCN3 of the Permafrost_CCI project.

1.3 Preface

The **rock glacier velocity (RGV)** is strongly linked with the geomorphologic processes in permafrost areas and it is particularly sensitive to changing climatic conditions. Under this circumstances it is considered an important attribute for RG inventories and it has been accepted as an essential climate variable (ECV) for permafrost by both Global Terrestrial Network for Permafrost (GTN-P) and Global Climate Observing System (GCOS.)

1.4 Temporal Coverage

The RG Velocity was computed from 2015 to 2021, with Sentinel-1 data available annually and intra annually. The in situ validation was computed with data from 2018 to 2021. The RG inventory refers to an inter annual period (RGKI 2022).

1.5 Spatial Coverage

The RG Velocity cover the Retezat Mountains in the Western Part of the Southern Carpathians. The RG inventory covers the whole of the Southern Carpathians.

1.6 Data availability and release

The RGV data is available through the Terrasigna data Portal (HTTP://PSTOOL.TERRASIGNA.COM). The updated RG inventory will be made available, after it has been published in a peer-review journal, via a research community data portal (e.g. https://www.unifr.ch/geo/geomorphology/en/research/cci-permafrost.html) and/or, if needed, as a supplementary material to the published article.

2 EXAMPLES OF PRODUCTS GENERATED BY PERMAFROST_CCI CCN1 EXTENSION

2.1. Study area

The study area is a mountain range in the western part of the Southern Carpathians (45º22' N; 22º53' E), covering 413 km2 and reaching 2509 m at its highest point. The existing rock glacier inventory was made in 2017 by the West University of Timisoara (Onaca et al., 2017). Morphological and ecological criteria were used to differentiate between intact and relict rock glaciers. The greatest rock glacier density in the Romanian Carpathians is encountered in the Retezat Mountains (0,52 rock glaciers/km2). Based on the morphological and ecological evaluation, 30 rock glaciers (from a total of 94) were classified as intact rock glaciers (Onaca et al., 2017). In this mountain range rock glaciers are mainly located between 1850 and 2250 m.
Recent geophysical measurements have shown that the internal deforming frozen layer within the investigated rock glaciers appears to be very thin (Onaca et al., 2015). Moreover, permafrost has a patchy distribution within the investigated rock glaciers (Onaca et al., 2015).

2.2. Rock glacier velocity (RGV)

The rock glaciers velocity was measured from space using SAR data acquired by the ESA Sentinel-1 mission and processed with the PSInSAR (Persistent Scatterers Interferometry) technique. The analysis of Sentinel 1 data was performed in the alpine area of the Retezat Mountains with 2015-2021 descending acquisitions from May to October of each year. Due to the sparse vegetation of the alpine region the processing led to a high density of measurement points on the ground, including the rock glacier areas. The results clearly illustrate areas of distinct dynamics (Fig 1) The clustering of points with a higher displacement rate than the surrounding area are identified as moving areas (MA) (Bertone et al., 2022) related to the presence of rock glaciers. The point-based displacement map is freely available on the TERRASIGNA PSI Tool online platform (http://pstool.terrasigna.com). .

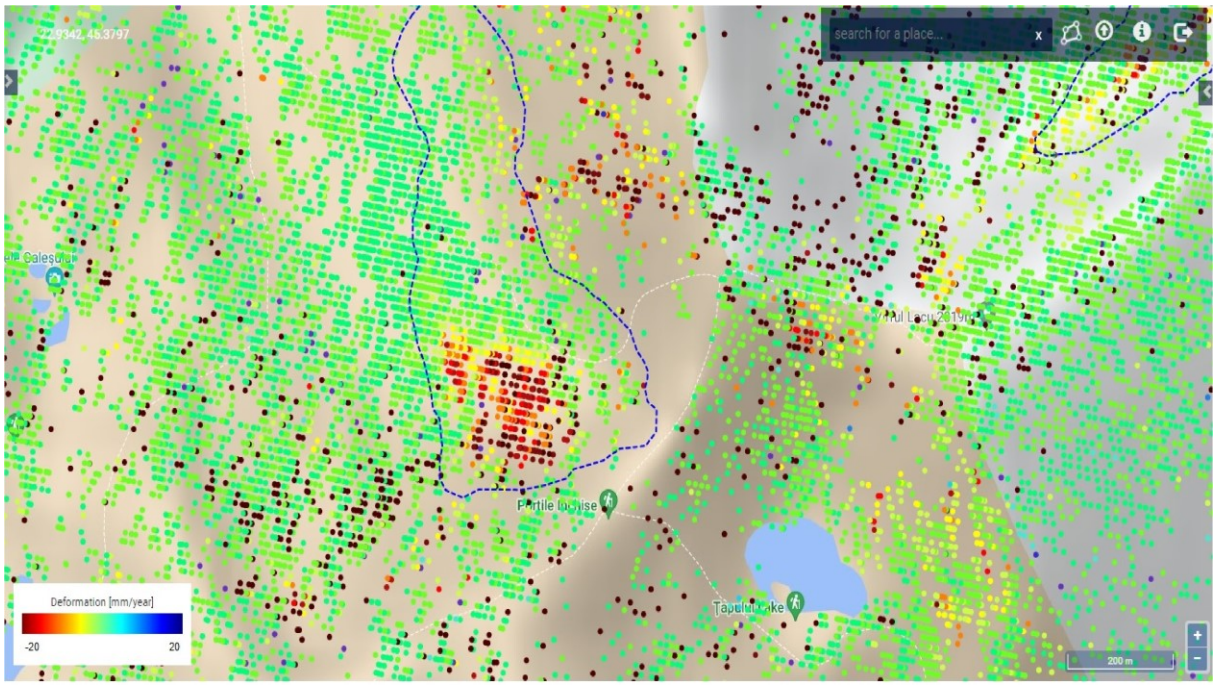

FIG. 1 DISPLACEMENT MAP IN GALESU AREA, RETEZAT MOUNTAINS. A MOVING AREA CAN BE IDENTIFIED IN THE UPPER (SOURTHERN) PART OF THE GALESU ROCK GLACIER (DASHED LINE).

To validate the remotely sensed RGV, in situ measurements have been performed using A TopCon Hyper V Differential GPS for acquiring high precision positioning data. The Hyper V receiver is built with a high-performance 3.5 G modem and a UHF radio card that allows the receiver to be connected to the reference networks (i.e. ROMPOST – Romanian real-time positioning network) but also to be used in a Base-Rover (RTK) configuration.

The measurements were performed in multiple locations on two RGs. For some points the measurement was in the instrumental error and thus was considered to be in a location with no measurable velocity and thus being classified as “undefined” (see section 2.3 for used classification). The rest of the measured displacement rates are in the interval of between 3 and 28 millimetres/year and were recorded for both Judele and Berbecilor rock glacier (Fig. 2).

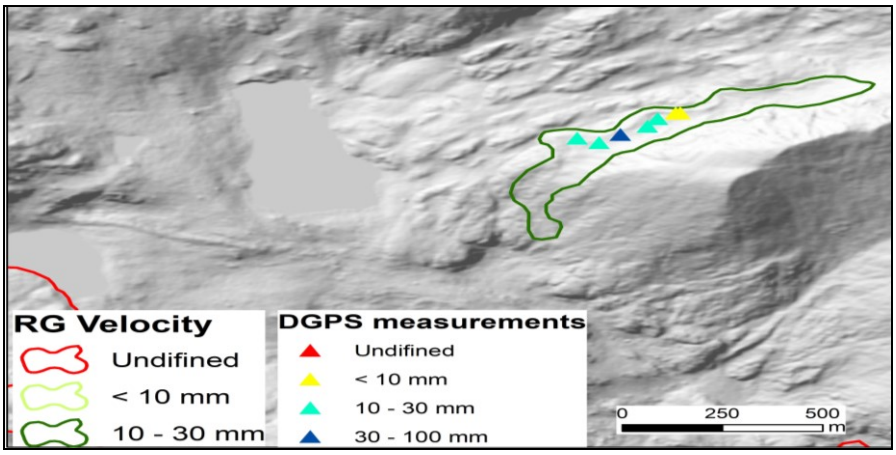

FIG. 2 DGPS MEASUREMENTS ON THE BERBECILOR ROCK GLACIER.

2.3. Rock glacier inventory update

The rock glacier inventory has been updated using the version 3.1. of the baseline concepts, provided by the IPA action group "Rock glacier inventories and kinematics" (RGIK, 2022).

Both the methodological principles (e.g. choosing the right technique for the study area, cross validation with a different technique, minimum number and spatial distribution of points) and the general considerations for RG inventories (e.g. temporal and spatial resolutions, consistency, relative error) were followed in order to insure that the final product respects, at list, the minimum requirements to be considered a reliable source of data by the international community.

Because of the marginal periglacial conditions, the velocity of these landforms is very low compared with other active rock glaciers located elsewhere. The velocity classes of the rock glaciers were established, according to the baseline guide and the existing literature (Barboux et al., 2014; Bertone et al., 2022), as follows: "Undefined" (low reliability and/or no detected movement), "<10 mm/year", "10-30 mm/year" and "30-100 mm/year".

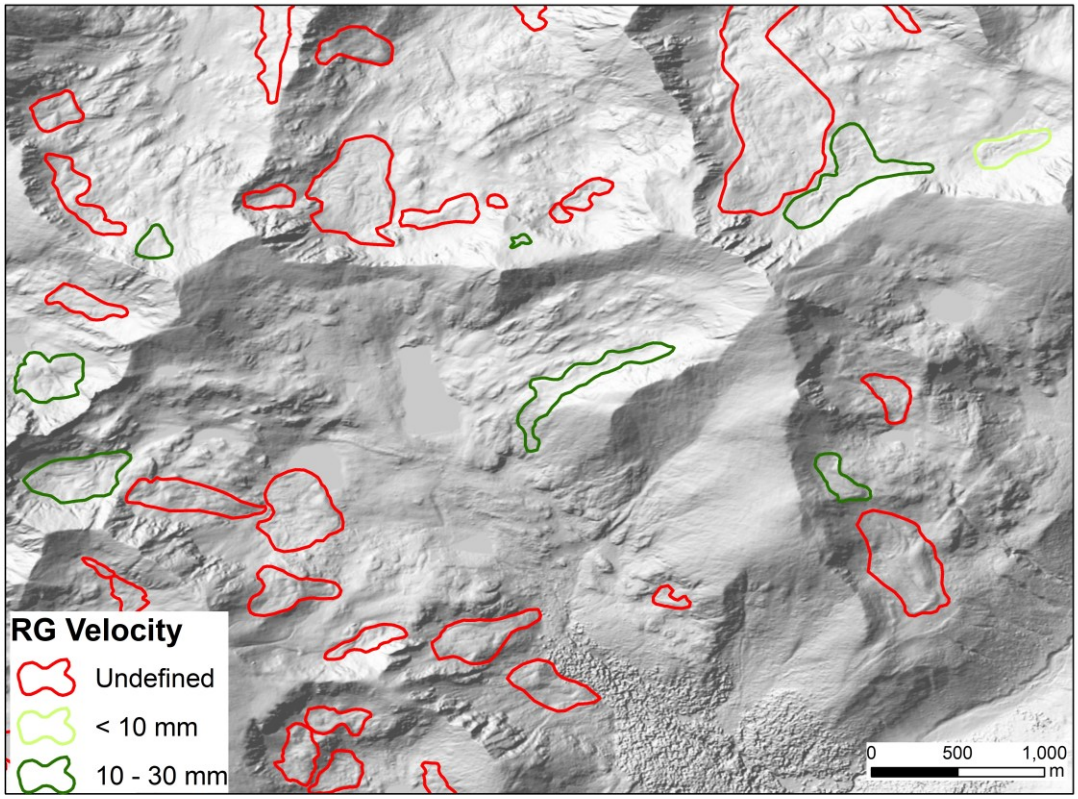

FIG. 3 ROCK GLACIER INVENTORY, WITH VELOCITY CLASSES, FOR THE CENTRAL PART OF THE RETEZAT MOUNTAINS

The RG inventory for the Southern Carpathians has been presented and discussed within the Romanian permafrost community and it is intended to be published, with complementary data, in a peer review journal. After publication the updated inventory will be made freely available.

3 REFERENCES

3.1 Bibliography

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3.2 Acronyms

B.GEOS	b.geos GmbH
CCI	Climate Change Initiative
CRDP	Climate Research Data Package
ECV	Essential Climate Variable
ESA	European Space Agency
FOSS	Free Open Source Software
GAMMA	Gamma Remote Sensing AG
GCOS	Global Climate Observing System
GTN-P	Global Terrestrial Network for Permafrost
GTOS	Global Terrestrial Observing System
GUIO	Department of Geosciences University of Oslo
IPA	International Permafrost Association
RG	Rock Glacier
RGV	Rock Glacier Velocity
RMSE	Root Mean Square Error Rock Glacier
WUT	West University of Timisoara